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TECHNICAL NOTE

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A NEW METHOD OF WASTE DISPOSAL FOR ISOLATED SITES IN THE ARCTIC. II.

Studies Covering Period from September 30, 1958 through December 31, 1958.

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A NEW METHOD OF WASTE DISPOSAL FOR ISOLATED SITES IN THE ARCTIC. II.

John A. Logan*

INTRODUCTION

Burner tests have been conducted to determine requirements for a prototype oil carriage waste disposal unit. The results of these tests are reported herein.

BURNER TESTS

Investigations of burner devices indicated that the rotary cup burner was the most feasible type, considering reliability, metering characteristics, and combustion efficiency. Preliminary tests were successful, and are discussed in the first report of this series, TN 59-5, published by the Arctic Aeromedical Laboratory.

A full-scale functional test of the rotary cup burner was necessary to fully determine its operating characteristics. Williams Brothers and Miller, Inc., combustion engineers and burner manufacturers, provided a rotary cup burner, test facilities, and consulting services under a subcontract. The object was to study the possible troubles that might arise in the burning of a slurry and to lay out the design specifications for a special burner, and special metering and modulating controls.

The following general areas must be considered in development of a

* Technological Institute, Northwestern University. Work performed under Contract No. AF 41(657)-207, monitored by the Arctic Aeromedical Laboratory.

burner package:

1) Transport. The oil-waste slurry must be pumped and metered with reliability and positive control.
2) Atomization. Oil and water must be atomized sufficiently to permit efficient combustion of the oil.
3) Combustion of wastes. Wastes must burn completely without excessive boiler slagging and without other significant reduction of boiler efficiency.
4) Durability. Materials must resist corrosion and abrasion for long periods of operation.

It was decided (as a matter of economy) to set up and test a conventional burner package with modifications made as difficulties arose, rather than to design a new unit immediately. Note that the conventional unit was avilable and its characteristics with oil were well known.

Test equipment for the burner package:

1) Test furnace. The Williams Brothers and Miller test furnace is approximately 6 feet in diameter and 10 feet in length, of steel construction, refractory lined. The unit was especially designed for burner testing, with windows for observing combustion characteristics. The conditions to be found in a refractory firebox boiler (believed to be the type and size used in Alaska) are closely simulated. (See figure 1.)
2) Slurry tank. The 60-gallon slurry tank has a cone-shaped bottom. Oil feed and return lines enter at locations which permit the most homogeneous mixture to be fed to the burner. A one-third horsepower variable speed agitator is mounted on the tank. This unit

is fitted with two impellers. (See figure 1.)

3) Feed lines. Slurry lines are made up of 3/4-inch copper tubing and 1/2-inch black iron pipe (screwed fittings).

4) Measurements. Measurements are made of pressure, temperature, and flow rate.

The test slurries used number one fuel oil as a vehicle rather than Polar Diesel oil because of its low cost and immediate availability. Final burner tests will be made with Polar Diesel oil. The slurries were as follows:

1) Oil with 10% by volume activated sludge. The sludge was obtained from a local sewage plant and thickened to 5% solids by weight.

2) Oil with ground toilet paper and sludge. Toilet paper was 5% of waste by weight. Waste concentration in oil was from 2% to 25% by volume.

3) Oil with ground garbage:

   a) 55% potatoes by weight
   b) 27% cabbage
   c) 12% bread
   d) 6% rice, uncooked

   This was mixed 10% by volume with 90% oil.

The sludge and paper are believed to simulate human wastes physically, while the garbage was tried to acquire sufficient information on general refuse handling if it should become desirable to introduce garbage into an existing system.

TEST PROCEDURE AND RESULTS

1) Preliminary tests were made on the conventional burner pack using the sludge-oil slurry. The conventional pack is shown in figure 2. Six hours of operation were sufficient to prove that the conventional metering devices would not handle the slurry reliably. The digital totalizer failed to operate immediately, and the modulating valve and needle valve clogged and operated erratically.

2) A metering system incorporating a positive displacement pump with a variable speed control was designed to replace the pressurized orifice metering system. Orifice and pump metering systems are shown in figure 3. The new system was operated for 6 hours with the sludge-oil slurry. No difficulties were encountered with metering, transport, or combustion.

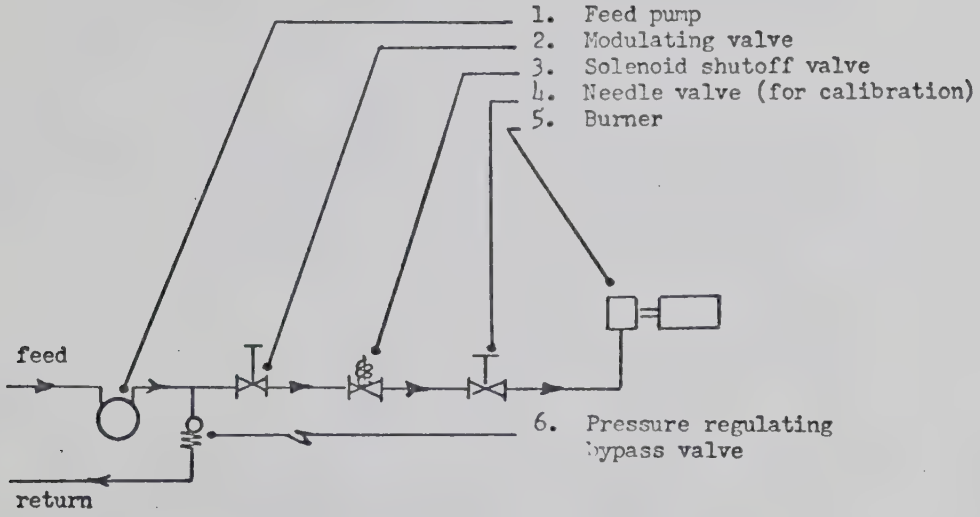
The sludge-paper-oil slurry was burned for 5 hours at concentrations from 2% to 25% waste. It was necessary to modify the tank agitator design as shown in figure 4 so that the ground paper was well distributed throughout the slurry.

The rotary cup tended to clog within about 15 minutes when concentrations approaching 20% were used. Fibrous waste components (suspected to be the paper) accumulated behind the impeller and in the cup. The deposits did not char and were easily and quickly removed.

The fibrous accumulation appeared only with high concentrations, but the runs were of short duration. Indications were that at low concentrations (10% or less) the oil would scavenge the cup completely, but additional tests will be necessary to verify this conclusion.

Figure 3. Oil Burner Metering Systems

A) Conventional system:



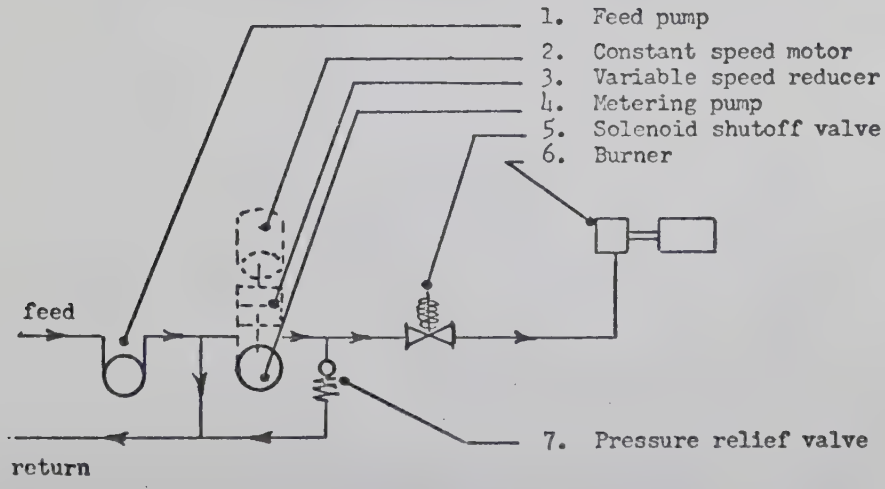
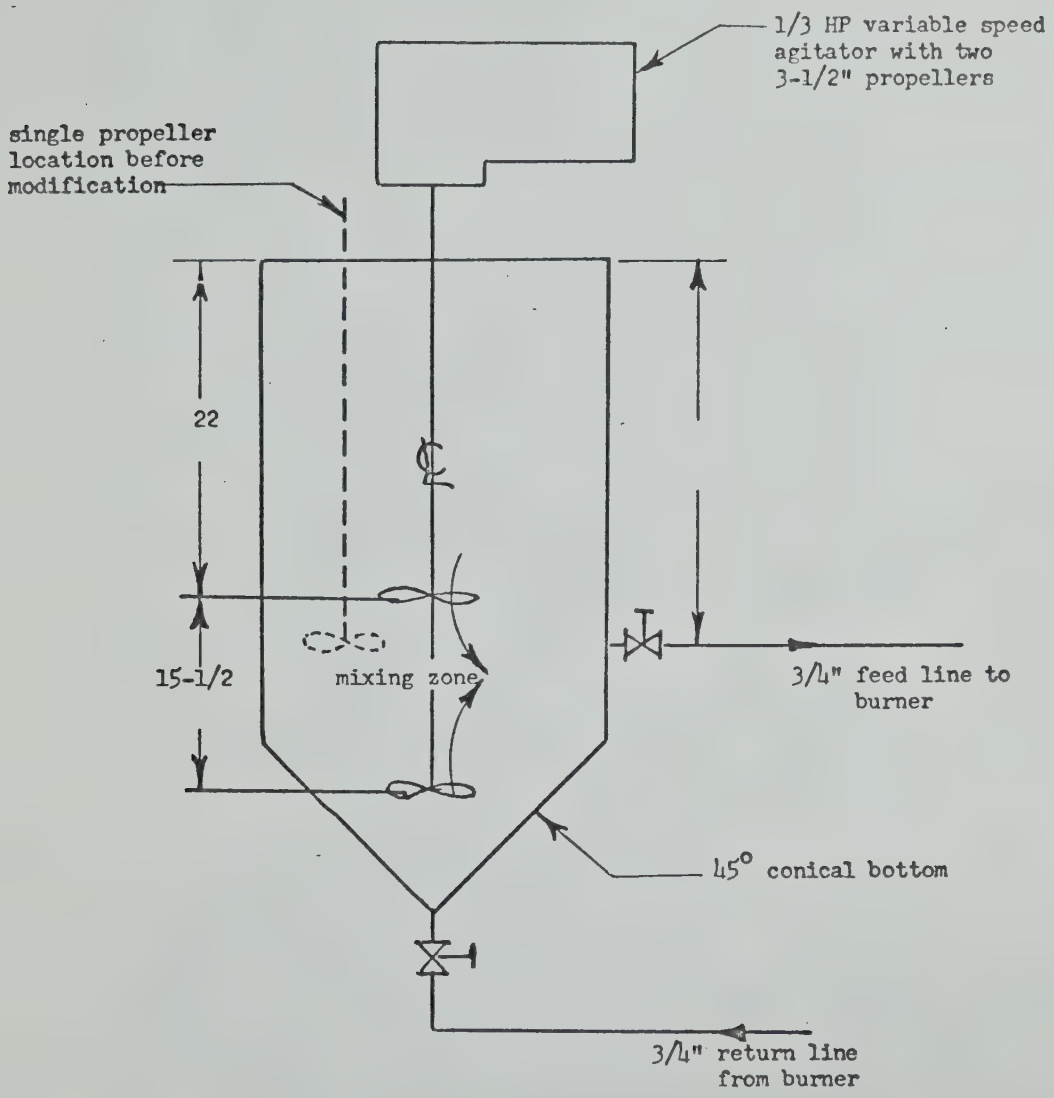


Figure 4. Dimensional Sketch of Slurry Storage Tank for Burner Tests
(22-1/4" diam. by 33-1/2" deep - 66 gallons)



Six hours running with low concentrations seemed to indicate that clogging would not occur with concentrations of 10% or less, but the results were not conclusive for long periods. It was decided that time and money could be saved by using a bench test apparatus to determine atomizing characteristics of the oil-waste mixture under cold test conditions. This apparatus is being constructed. Tests will begin on December 1st, 1958.

3) Tests were also conducted with representative samples of ground garbage. Combustion appeared to be no problem. Particle size requirements of the burner were determined. It is not known whether burning garbage would be desirable or feasible (because of the large quantity). If this becomes necessary later, however, only a small amount of additional development will be required.

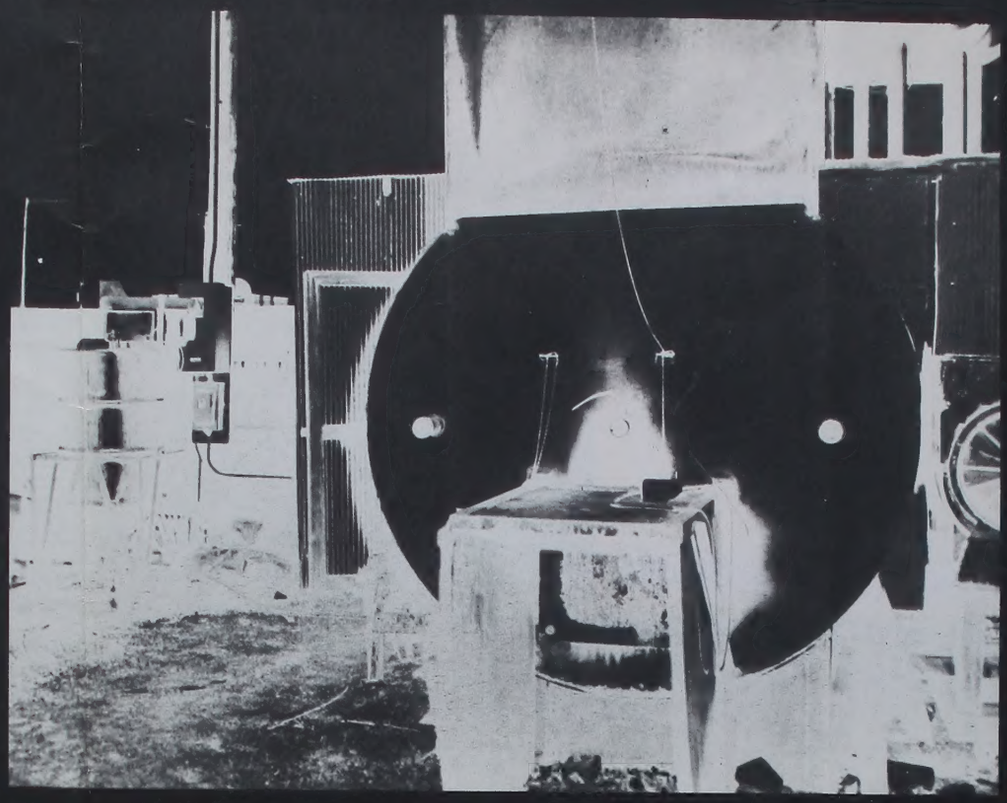


Figure 1: End view of Williams Brothers and Miller, Inc. test furnace. The furnace is 6 feet in diameter by 10 feet long, refractory lined, with observation ports on the side and ends. Burner and controls are housed in the test cell. At left is the slurry tank with agitator.

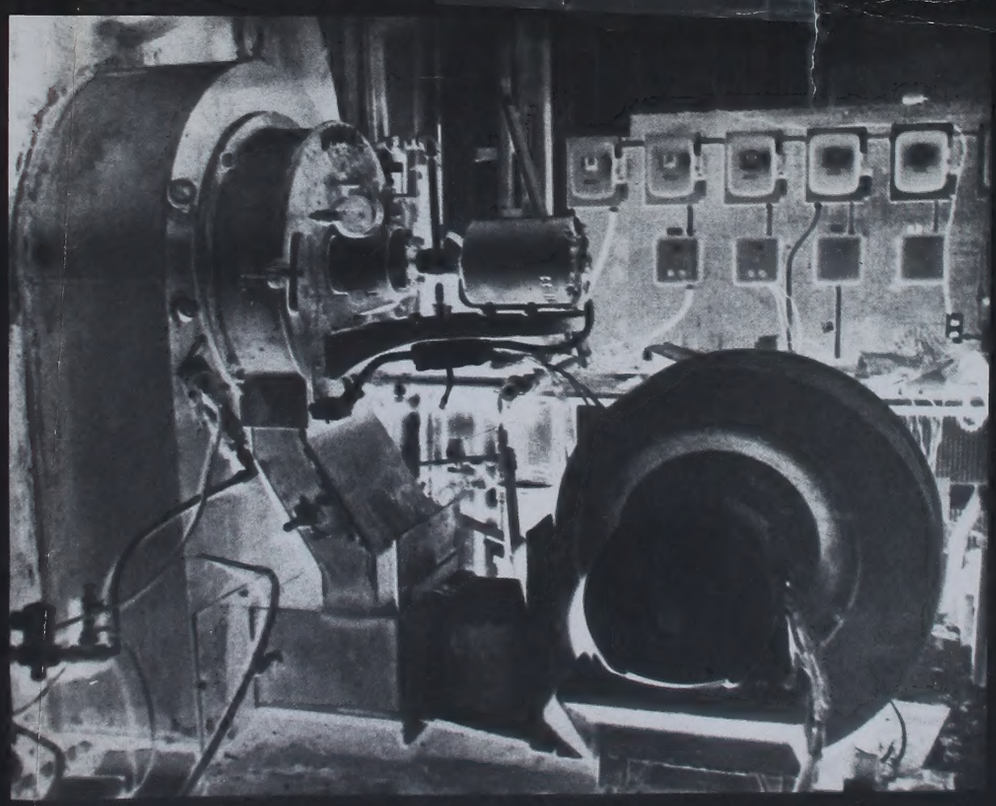


Figure 2: Conventional burner pack. This unit has a total air blower (at right). The Alaska unit will use a primary air blower, since secondary air is moved by induced draft. Natural gas pilot is at lower left. The Alaska unit will use a small oil-fired pilot burner. Metering devices are not visible.